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Research and Analysis on the Application of Radio Frequency Identification Technology in the Internet of Things and Future Development

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Abstract. In the past five years, 5G technology has been widely used, with its development and popularity. "Internet of Everything", that is, through the 5G technology will be all aspects of life together, this concept gradually into the people's field of vision, in a series of 5G-related technology, radio frequency identification technology as one of the important thing Internet technology has received widespread attention. This article will be based on a combination of a literature review and case study method, a brief introduction to RFID technology and its application in the Internet of Things in the current situation and future development of the analysis. This paper provides some inspirations and suggestions for the practitioners in the field of Internet of Things (IoT) through in-depth discussion of the application of RFID technology in IoT; by analysing the application cases and challenges of RFID technology, it can provide important references for the promotion of intelligent development of Internet of Things (IoT).

Keywords: Internet of Things, Radio Frequency Identification Technology, 5G technology, Big data.

1. Introduction

Radio Frequency Identification (RFID) technology is widely used in the Internet of Things (IoT), covering a wide range of fields such as logistics management, smart manufacturing, agriculture, healthcare and so on. Nowadays, scientists are developing smaller, cheaper and more functional RFID tags to meet the needs of different application scenarios. At the same time, they are also researching how to use the big data collected by RFID technology for analysis and develop corresponding algorithms and tools to achieve real-time decision-making. In addition, RFID, as part of the Internet of Things, is being integrated with other sensors and devices to build smarter systems and applications. However, energy management, interoperability and standardisation, cost and scalability, data processing and real-time performance of RFID technology are still issues that need to be further researched and addressed. The rise of the Internet of Things (IoT) provides a broader application scenario for the development of RFID technology. This study aims to explore the application of RFID technology in IoT, analyse its application in different fields, examine its problems and challenges, and explore future development trends. This study will conduct in-depth research on the application of RFID in the Internet of Things by means of a literature review and case study analysis, analysing its working principle, current development status, and problems and challenges, as well as exploring solutions and future development

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trends. This study is of great significance for promoting the intelligent development of Internet of Things, and through in-depth analysis of the application of RFID technology in Internet of Things, it can provide important references for the future development of the Internet of Things and RFID technology, and promote the application and innovation of RFID technology in more fields.

2. An overview of RFID

2.1. The working principle of RFID

As a type of non-contact automatic diagnosis technology, radio frequency recognition technology makes use of the spatial coupling transmission characteristic of radio frequency signals to realize automatic diagnosis of static or moving articles. Other names for RFID technology include non-contact cards, electronic labels, induction cards, and induction electronic chips. A reader, a transponder, and a Taq make up a basic RFID system. The transponder powers the circuit and scans the ID code stored in the transponder in a variety of ways when the reader sends radio waves at a specific frequency to it. Electronic tags with these designs have the benefit of excellent security and long life. Therefore, RFID tags can be affixed or installed in different items by installing in different geographical locations of the read-write reads the data stored in the tags, to achieve the automatic diagnosis of the items. RFID technology can be divided into low-frequency system, high-frequency system and UHF system according to the different frequencies of three categories. Low-frequency systems generally work in the range of 100 ~ 500 KHz, low-frequency systems have a strong penetration ability and are not easily affected by the interference of metal and water features, but there are also slower reading speeds, low data transfer rates and other shortcomings. Therefore, the system is mainly in the close range of the application is more common, such as access control systems and animal identification technology. High-frequency system frequency of 13.56 MHz, high-frequency system tags and low-frequency system, compared with its storage capacity is relatively large, faster reading speed, data transfer rate is higher, but there is a certain degree of interference with metals and liquids, the working distance is generally lower, suitable for logistics management and inventory management. The antenna shape of the tag in the UHF system is typically lengthy and tag-like. This system's two most noticeable features are its great reading distance and quick reading speed. Nevertheless, a lot of things, including water, dust, fog, and other materials with suspended particles, are impervious to radio waves in the UHF range. Thus, supply chain management and production line automation management are the system's primary uses [1].

2.2. RFID development status

In recent years, RFID technology has developed rapidly and has been widely used in many fields. On the whole, the domestic sector mainly deals with identification, traffic management, military and security, asset management and logistics and warehousing and other areas of application of RFID. And RFID in foreign applications, retail and transport logistics occupy the absolutely main force. The two together are about 40 per cent of the whole market. "In terms of the total number of RFID tags applied, it will be close to 6 billion in 2016 and close to 27 billion in 2021; in terms of the production value, it will be more than US$390 million in 2016 and more than US$1.4 billion in 2021." [1] According to the forecast, the RFID market size will reach USD 14.98 billion by the end of 2024 and USD 26.01 billion by 2029, growing at a CAGR of 11.68% during the forecast period (2024-2029). However, in the consumer sector, the use of RFID tags is currently limited to logistics and sales, with fewer applications in production. The supply chain system can more easily and automatically track the dynamics of commodities and realize automated item management thanks to the unique identification method and technological features of RFID technology. Additionally, RFID technology offers the retail sector more sophisticated and practical data collection techniques, user-friendly customer transaction forms, effective operational techniques, and highly perceptive decision-making tools [1].

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3. Internet of Things

3.1. Basic concept of Internet of Things

With the rapid development of modern science and technology, the Internet of Things (IoT) came into being under the derivation of the Internet and computer technology, which realises the connection of things, and deeply affects the development of the modern economy while greatly changing people's lifestyles. Generally speaking, the Internet of Things is based on the Internet, through the sensing technology, radio frequency identification technology and other technologies, different things are connected to each other, through the smooth exchange of information and timely communication, to achieve a network of layer by layer links [2]. Usually, IoT construction system is divided into three layers: perception, network transmission ,and application. First, the perception layer is located in the bottom of the IoT structure, mainly responsible for sensing and identifying objects and collecting information. It collects data such as temperature, humidity, light, etc. in the environment, or identifies information such as shape and colour of objects through various sensors and devices, and converts this information into processable data and is then passed upwards to the network layer. Secondly, the network layer is mainly responsible for processing and securely transmitting the data collected in the sensing layer to the application layer. Third, the application layer is located at the top of the IoT structure, which is responsible for computing, processing and knowledge mining of the data collected in the perception layer and combining it with applications in various industries so as to realise real-time control of the physical world, precise management and scientific decision-making.

3.2. The importance of the Internet of Things

Unlike the old way of connecting things, the Internet of Things (IoT) is a fusion of physical and Internet facilities. Smart wireless communication for cellphones, desktop computers, military installations, automobiles, and other devices is made possible by this technology. In the future, practically every part of a person's life can be connected through smart devices due to the Internet of Things' rapid development, and everything can be used or transferred through it without any restrictions. To keep up with current trends, the Internet of Things must be developed, and radio frequency identification technology development is essential to the development of the Internet of Things [3].

4. RFID technology in the Internet of Things

4.1. The main application areas of RFID technology

4.1.1. Application in intelligent logistics management system. The application of RFID technology in intelligent logistics management system mainly includes the following three aspects. On the one hand, it is applied in the field of transport and logistics. By installing RFID tags on the goods, the logistics enterprises can obtain the real-time status and location of the goods at any time, so as to realise real-time tracking and monitoring of the goods, respond to emergencies in a timely manner, and ensure the safety of the goods in the transport process. Second, the application of inventory management system, through the installation of intelligent shelves and Internet of Things sensors, can achieve real-time monitoring of inventory. And through the intelligent inventory management platform, it can achieve an accurate grasp of inventory data and successfully eliminate the occurrence of overstocking phenomenon. Thirdly, in terms of vehicle scheduling and route optimisation, through GPS and GIS systems, logistics companies can monitor the location of vehicles in real time, dynamically adjust distribution routes and schedules according to real-time traffic conditions, shorten distribution time and reduce transport costs. It can also analyse historical logistics data to optimise vehicle scheduling strategies, improve vehicle utilisation and increase transport efficiency [4].

4.1.2. Application in the field of intelligent medical health. Application in the field of intelligent medical health

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In the process of building an intelligent medical system, Internet of Things technology is an important cornerstone for realising medical informatisation, while RFID technology is an important tool to realise the construction of an intelligent medical system.RFID technology can be mainly applied in three aspects, one is patient tracking, by installing RFID tags on the patient's bracelet, the patient's location and real-time observation status can be remotely tracked and when an emergency situation occurs in the patient, the Healthcare personnel can quickly respond according to the patient's location and information provided by the RFID tag, thus improving the efficiency of medical services and greatly reducing costs [5]. Secondly, in terms of medical device tracking and management, by using RFID tags on medical devices and installing RFID readers and writers in specific locations in hospitals, RFID central management systems can track the location of devices in real time, preventing them from being lost or stolen and ensuring that they can be found quickly when they are needed. In addition, RFID can be used to track the use and maintenance records of medical device equipment to help hospitals better manage these devices [6]. Third, the application of medical waste management, medical waste to the outside world has great potential danger. The use of RFID technology can easily achieve the collection, classification, packaging, weighing, transport, storage, disposal and other full-process traceability management of medical waste in circulation in the hospital, reducing the spread of infectious diseases or environmental pollution caused by improper handling of medical waste [7].

4.1.3. Application in the wisdom of animal husbandry. The livestock industry can benefit from RFID applications in three main areas. Firstly, farms can use RFID Internet of Things technology to manage livestock and poultry production. This allows for advanced, non-contact rapid identification of animals from birth to slaughter, without having to record any information. This helps farms quickly assess the true state of the production and ensures the safety and health of animal breeding as well as the production of livestock and poultry products. Secondly, the tracking and tracing of livestock and poultry products, the livestock industry belongs to the systematic production and manufacturing industry, the industry's main feature in the production process is that the production of products is irreversible, which leads to the occurrence of food safety problems, it will be very difficult to trace back to the source, and now through the RFID system, it can be effectively realised on the tracking of livestock and poultry products, and deal with the problem in time [7]. The third is the application of rapid quarantine in livestock and poultry, the use of RFID systems, the Internet of Things can be comprehensive coverage of large-scale livestock and poultry slaughtering plants, various product wholesale markets. Through the animal quarantine related data and information base for livestock and poultry production products, such as violation of the state of health and other related situations for scientific and pratical monitoring and data recording, to ensure that the product of the whole process of tracking. [8].

4.1.4. Application in security anti-counterfeiting. Anti-counterfeiting is often achieved by attaching security labels to products that are easy to manufacture but difficult to duplicate and can be detected if tampered with. For anti-counterfeiting verification, the HASH value of the product information can be decrypted and extracted using the public key of an authentication centre, compared to the value of the HASH function stored in the tag, and determines whether the product was produced by the manufacturer. These features make the inclusion of anti-counterfeiting chips manufactured based on RFID technology widely utilised [9].

4.2. The future development trend of RFID technology in the Internet of Things

With the continuous development of the Internet of Things, RFID technology as its core technology will be a brand new technology growth point in the future. It can be predicted that the future development of RFID technology will have the following trends :

- Tag product diversification: The future of RFID tags will be based on the user's individual needs for diversified design. This personalisation includes chip frequency, capacity, antenna design, packaging materials, etc., so that the product can provide a wider variety of functions, such as the combination of sensors, GPS, biometrics and other technologies to achieve multi-functional identification.

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- System networking: With the popularity of RFID technology, each product can obtain a unique identity through electronic tags. These tags combined with the Internet and e-commerce will become the future trend. This networked application will make the acquisition and management of information more efficient and intelligent.
- System compatibility: With the unification of standards, the compatibility of RFID systems will be enhanced. This means that RFID products produced by different manufacturers can be better compatible with each other, product substitutability will be enhanced. This development will promote competition and innovation in the market and promote the application of RFID technology in a wider range of areas.
- Integration with other industries: RFID technology is not limited to its own applications, but also with other IT industries such as computers, communications, consumer electronics and other in-depth integration. Once the problems of standardisation and key technologies are solved, RFID technology will be able to be more widely used in cross-industry and cross-region scenarios, forming larger industry clusters and promoting the development and innovation of the whole industry [10].

5. Conclusion

In the 21st century, the Internet of Things, as an extremely crucial technological innovation achievement, is bound to promote the future society to achieve breakthrough development again. The significant value of this paper lies in deeply exploring the application status and future development trend of RFID technology in the Internet of Things, providing meaningful suggestions for decision-makers in various fields and providing important references for promoting the intelligent process of the Internet of Things. As the core pillar of the Internet of Things, the development dynamics of RFID technology determines the forward direction of the Internet of Things in the future. With the gradual reduction of RFID tag costs, the continuous increase of labor costs and the unification of international standards, it is believed that RFID technology will develop more and more rapidly. Its role in the future will be even more crucial and effectively boost the development of the Internet of Things and lead human society to continuously move forward in the direction of modernization and intelligence.

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